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Published in:

Poster abstract in the Proceedings of the 14th World Congress on Anaerobic Digestion

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):

Escobar, E. J., Uellendahl, H. W., Njoku, S. I., & Kragelund, C. (2015). Thermal and enzymatic treatment of digested manure fibers in the re-injection loop concept to increase biogas yields. In *Poster abstract in the Proceedings of the 14th World Congress on Anaerobic Digestion: Reuse of effluent and digestate* IWA Publishing.

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Thermal and enzymatic treatment of digested manure fibers in the re-injection loop concept to increase biogas yields



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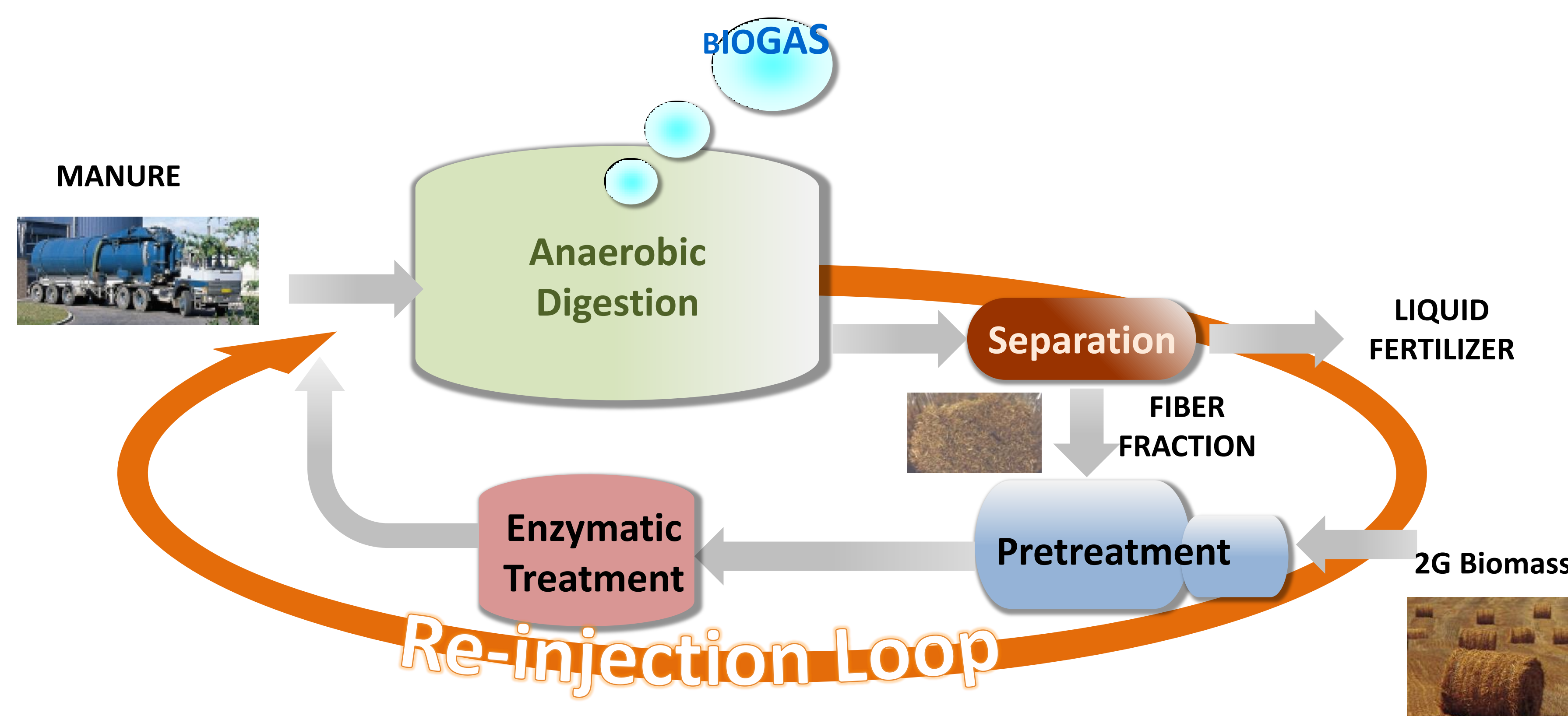
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Re-injection loop concept

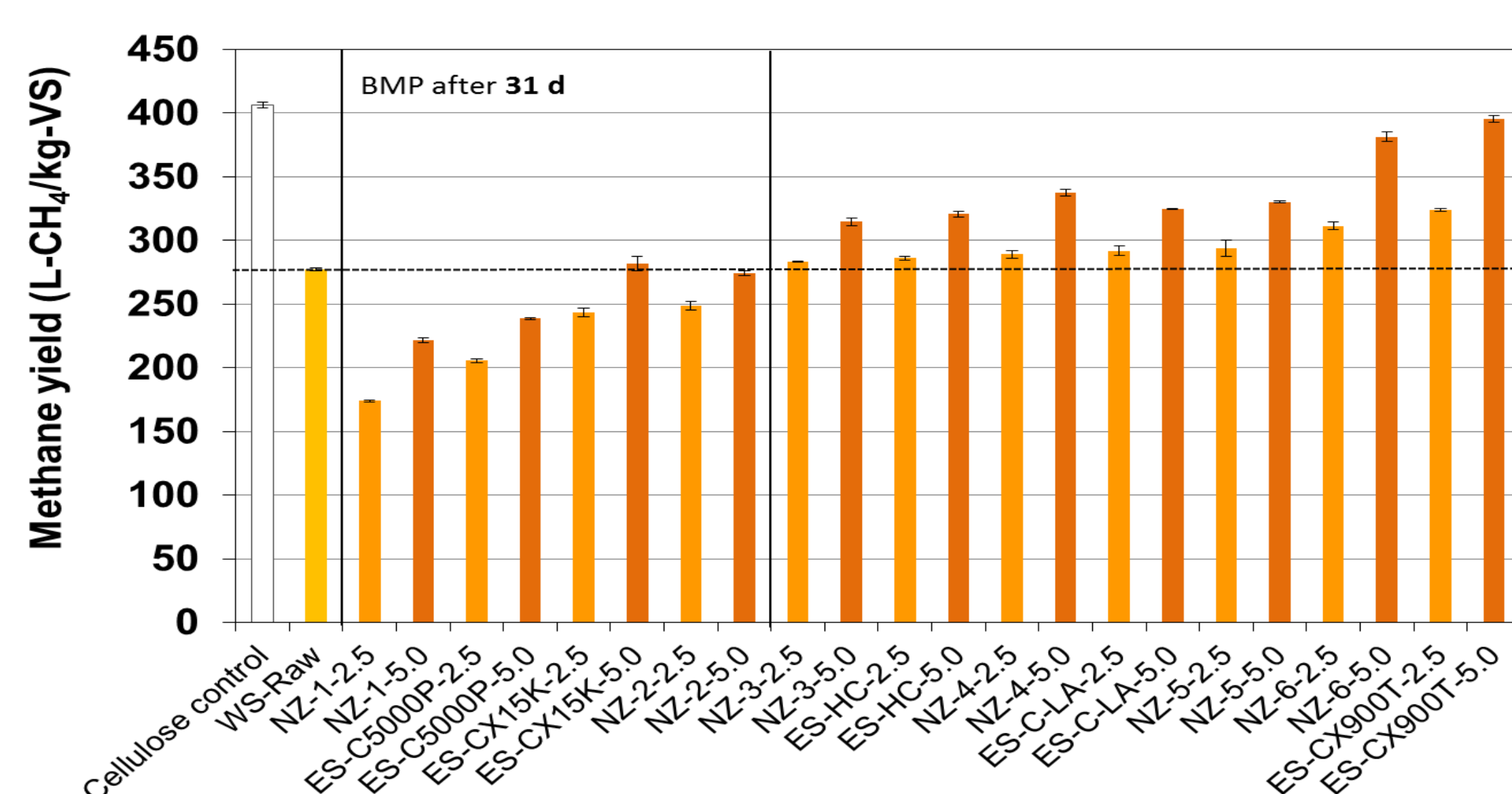
The reinjection loop is developed as an alternative to the conventional manure biogas treatment to increase the methane yield of the recalcitrant solid manure fraction and wheat straw (WS). This concept enhance biogas yield per tone of manure by:

1. Digestion of easy degradable compounds by anaerobic digestion.
2. Separation of solid and liquid fraction.
3. Treatment of solid fraction.
4. Reinjection of the treated solid fraction.

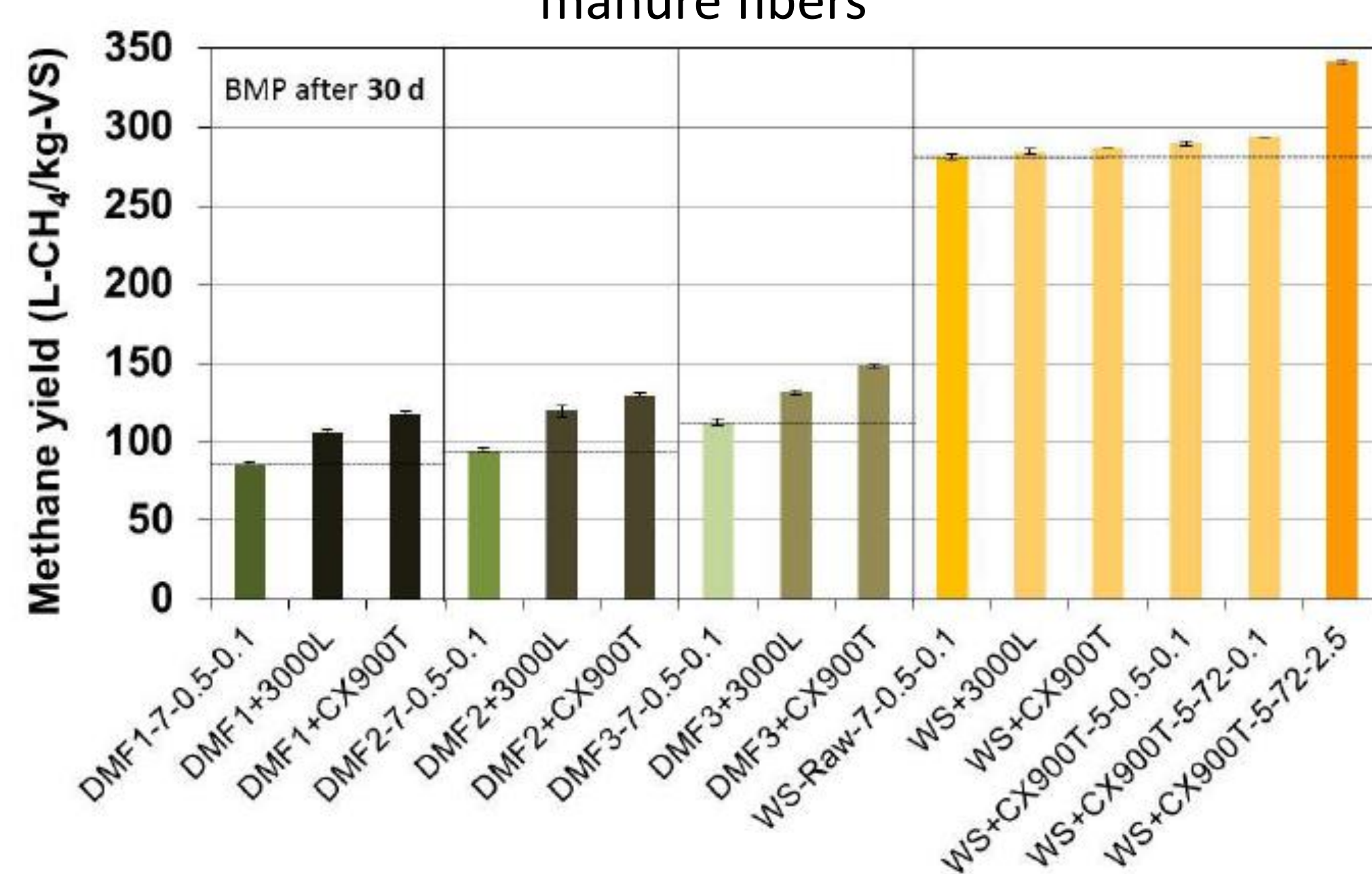


Enzymatic hydrolysis

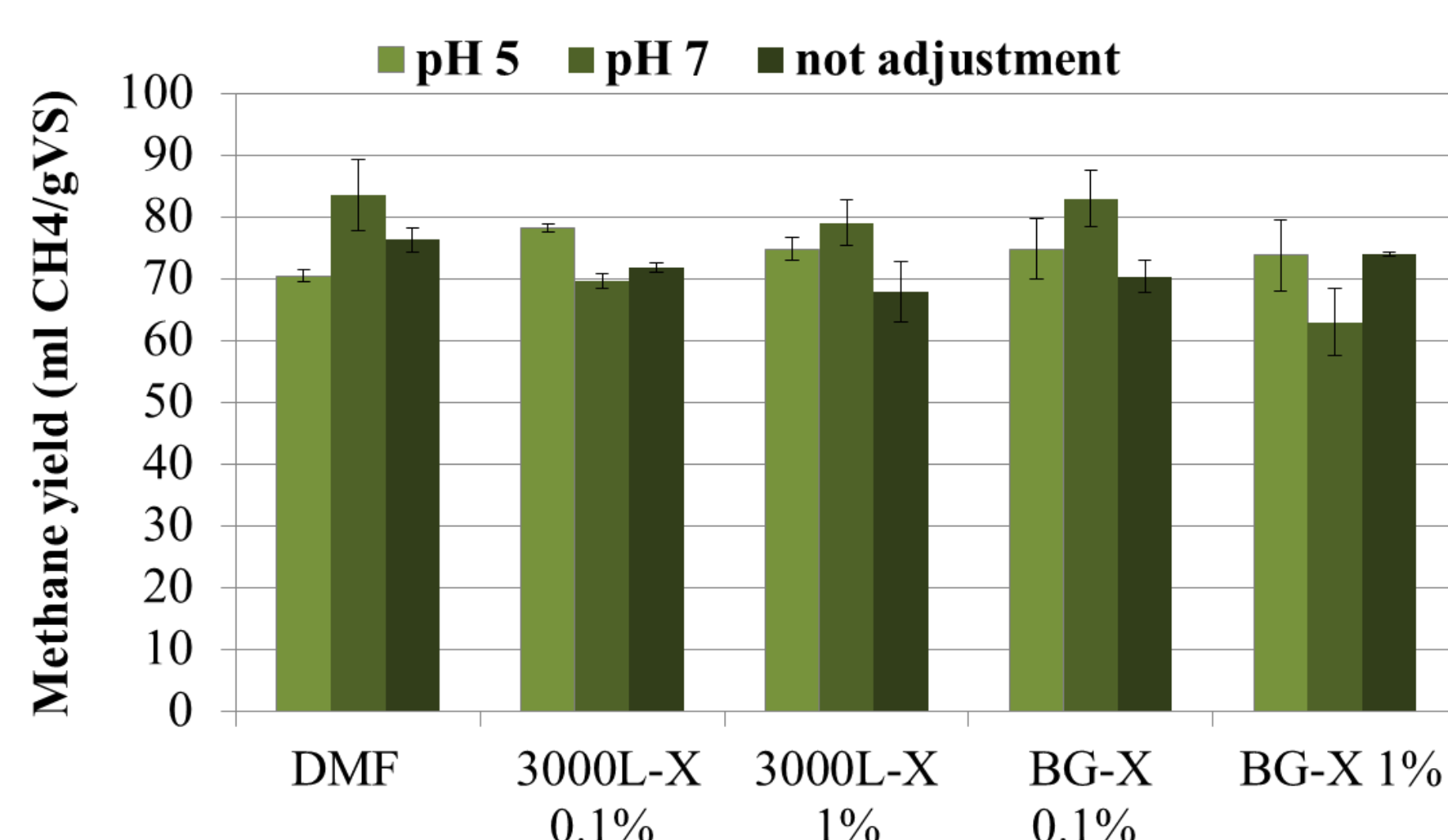
Initial screening of enzymes



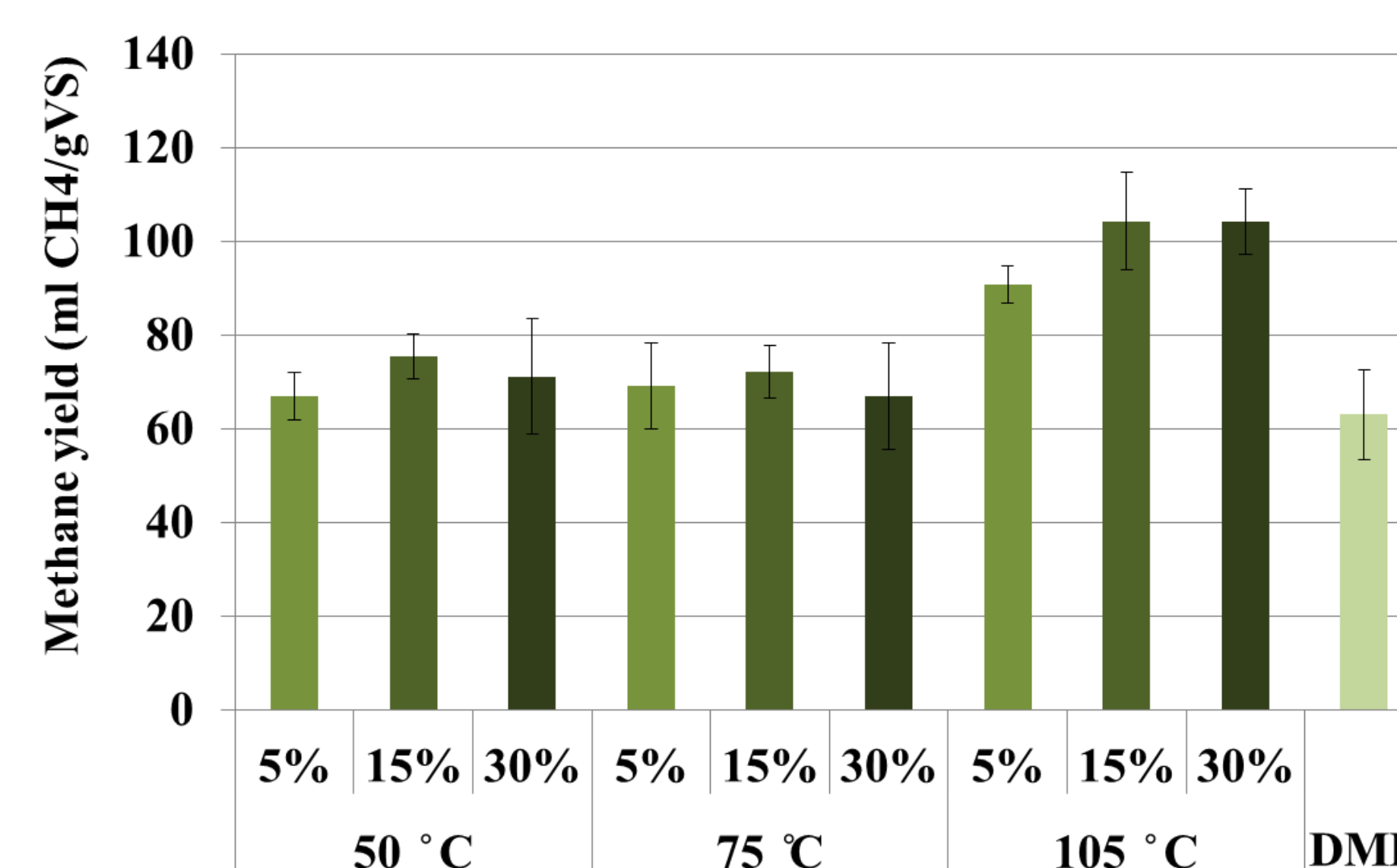
Testing of potential candidates on WS and digested manure fibers



Effect of pH and enzyme dosage



Thermal treatment



Economic analysis

VS %	Enzyme dosage	Increase of methane yield		Revenue
%VS of TS	g/g-TS	m ³ -CH ₄ /t-VS	m ³ -CH ₄ /kg-enzyme	€/kg-enzyme
75.0%	0.10%	10.00	7.50	4.05 €
75.0%	0.10%	15.00	11.25	6.08 €
75.0%	0.10%	20.00	15.00	8.10 €
75.0%	0.10%	25.00	18.75	10.13 €
75.0%	0.10%	30.00	22.50	12.16 €
75.0%	0.10%	35.00	26.25	14.18 €
50.0%	0.10%	35.00	17.50	9.45 €
75.0%	0.50%	35.00	5.25	2.84 €
50.0%	0.50%	35.00	3.50	1.89 €

*** The revenue is calculated as € per kg enzyme blend added, based on a revenue for selling electricity from biogas in Denmark of 1.15 kr./kWh_{el} = 0.15 €/kWh_{el}, equivalent to a price of 0.54 €/m³-CH₄ for the produced methane.

Conclusion

- Thermal treatment at 105°C for 1 hour showed to increase the methane yield by up to 65% compared to untreated DMF.
- The addition of enzyme blends showed to have no significant effect on increasing the methane yield of DMF, probably due to the high pH of the digested manure fraction, which is unfavorable for the activity of these enzymes.
- Economic evaluation show that the benefit of the treatment is more than 5 € per kg enzymes if an increase in methane yield by more than 12.34 m³-CH₄/t-VS can be achieved with a low dosage of 0.1% and a VS/TS ratio of 75%. It also shows that the benefit declines significantly if a higher enzyme dosage is needed and also the VS/TS ratio has quite an impact on the revenue.



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Acknowledgements

The EU BIOMAN project is funded by the European union's Seventh Framework Program managed by REA- under the grant agreement no. FP7-SME-2012, 315664

